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IS 3638 (1966): Application guide for gas operated relays  
[ETD 35: Power Systems Relays]



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**IS : 3638 - 1966**

***Indian Standard***  
**APPLICATION GUIDE FOR**  
**GAS-OPERATED RELAYS**

( Fourth Reprint APRIL 1996 )

UDC 621.316.925:621.318.5

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**BUREAU OF INDIAN STANDARDS**  
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**NEW DELHI 110002**

**Gr 3**

***September 1966***

# *Indian Standard*

## APPLICATION GUIDE FOR GAS-OPERATED RELAYS

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( Continued on page 2 )

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**IS : 3638 - 1966**

**( Continued from page 1 )**

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# *Indian Standard*

## APPLICATION GUIDE FOR GAS-OPERATED RELAYS

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 13 June 1966, after the draft finalized by the Relays Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** Gas-operated relay commonly known as Buchholz relay, is generally used for protection of oil immersed electrical apparatus like transformers. The relay is actuated by physical presence of gases or an oil surge or loss of oil in the relay. These effects arise from various electrical and mechanical faults in the apparatus or in special cases in the connected system. They are briefly discussed in the guide to outline the scope of protection.

**0.3** This standard has been prepared with a view to give guidance to the maintenance engineers of oil immersed electrical apparatus fitted with gas-operated relay regarding its application. It also gives guidance regarding the gas analysis and the colour of gases so that the cause of their occurrence may be ascertained. However, it is emphasized that this guide has been prepared to assist the users of such relays in its application rather than to specify the requirements for the relays which will be suitable for a particular system. The actual conditions in practice may be different from those specified here.

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### 1. SCOPE

**1.1** This guide covers application of gas-operated relays covered by IS : 3637-1966\* intended for use in the connecting passage of oil between the main tank of an oil immersed electrical apparatus and its oil conservator vessel.

### 2. TERMINOLOGY

**2.0** For the purpose of this guide, the definitions given in IS : 1885 (Part IX)-1966† and IS : 3637-1966\* shall apply.

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\*Specification for gas-operated relays.

†Electrotechnical vocabulary; Part IX Electrical relays.

**IS : 3638 - 1966**

### **3. GENERAL**

**3.1** The gas-operated relay responds if:

- a) prescribed quantity of gas is present in the relay,
- b) oil flows in the marked direction through the relay at the prescribed velocity, and
- c) oil in the relay sinks below the bottom of the pipe bore on the conservator side.

**3.2** The gas-operated relay provides the only reliable means of detecting incipient inter-turn and core faults in oil-immersed apparatus, which if allowed to persist can cause extensive damage. The relay may also give back-up protection against the worst effects of external faults.

**3.3** Should normal overcurrent protection fail to operate or operate with excessive time delay, when a through fault is fed by the protected apparatus, it may get overheated. The thermal effect of a prolonged external fault may produce small quantity of gas within the apparatus which in turn may cause gas-operated relay to respond.

**3.4** Minor faults in the apparatus generate gas at a slow rate. Severe faults generate gas at a high rate such that surge of oil may pass through the gas-operated relay. The relay can detect minor faults before they develop into major faults and it responds quickly to major faults.

**3.5** Weak earth faults on resistance earthed transformer with star winding may not cause differential protection to operate. No other conventional relay is useful in protecting the transformer against capacitance discharges, corona discharges and failures in the magnetic circuit. The gas-operated relay, however, provides the required protection.

**3.6** The types of faults that the gas-operated relay is capable of dealing with, are given in Table 1.

### **4. APPLICATION**

**4.1** It is usually adequate to choose the size of the relay according to the size of the protected apparatus. The practice for use with transformers is indicated below:

<i>Size of the Relay</i> (Nominal pipe bore diameter)	<i>Size of Protected Transformer</i>
mm	kVA
25	Up to 1 000
50	1 000 to 10 000
80	Above 10 000

AMENDMENT NO. 1    JANUARY 1987

TO

IS:3638-1966    APPLICATION GUIDE FOR GAS-OPERATED  
RELAYS

(Page 4, informal table under clause 4.1,  
col 2) - Substitute '1 001 to 10 000' for '1 000  
to 10 000' against Size of the Relay 50 mm.

(ETDC 35)

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Reprography Unit, BIS, New Delhi, India

**TABLE 1 NATURE OF FAULT AND CORRESPONDING RELAY RESPONSE**  
( Clause 3.6 )

SL No.	NATURE OF FAULT	RELAY RESPONSE
1.	<b>Minor Faults:</b>	
	a) Failure of insulation: on core bolts between core laminate of windings due to excessive eddy currents	Alarm " " "
	b) Over heating due to bad electrical contact	"
	c) Capacitance discharge to earth	"
	d) Corona discharge in bad oil	"
	e) Release of air from: fresh oil new windings, core, etc	" " "
2.	<b>Major Faults:</b>	
	a) Short circuit between: phase winding phase and earth winding turns winding tappings	Trip " " "
	b) Puncture to earth of bushing	"
	c) Open circuit by: disconnection of conductor joint conductor break	" "
3.	<b>Mechanical Faults:</b>	
	a) Sinking of oil level below the port on the conservator side due to low oil content or low oil temperature	Alarm and Trip
	b) Loss of oil by leakage	" " "
	c) Ingress of air through circulating system	" " "

**4.2 Mounting** — For satisfactory operation of the relay, it is desirable to pay adequate attention to its correct mounting in the working position. The reliability and speed of relay operation for certain faults depend to a large extent upon the size and design of the protected apparatus and the position of the fault within it. Detailed mounting instructions should be obtained from the manufacturer of the relay. The following guiding points may be noted in this respect:

- The pipe at the apparatus side should be straight for a length 5 times the diameter of the pipe bore;
- The pipe at the conservator side should be straight for a length 3 times the diameter of the pipe bore;
- The inlet and outlet pipes should meet the relay flanges at right angles;

**IS : 3638 - 1966**

- d) The pitch of the remaining pipe work shall be maintained as recommended by the manufacturer;
- e) Sharp bends in the pipe work shall be avoided;
- f) Between the take off from the tank and the inlet to the relay, the pipe work shall not be branched in any manner which may result in a possible by-pass of the oil or gas round the relay. The pipe shall be taken off from the crowning position over the tank;
- g) Depending on the dimensions of the protected apparatus, it is customary to provide a total elevation of 10 to 20 mm towards the crest of the tank where the piping to the relay takes off. In setting the apparatus to work, at site, care should be taken to examine that the designed elevation is not offset due to poor levelling;
- h) The mounting arrangement shall be as far as practicable, free from transmission of mechanical vibration; and
- j) The pet cock at the top of the relay shall be below the bottom of the conservator, whilst the distance between the bottom of the relay and the transformer bank shall not be less than 75.0 mm.

## **5. INDICATIONS**

**5.1** The gas collected in the relay may help to identify the nature of the fault. It is suggested that the following check tests be made as early as possible following the indication of accumulation of gas through the alarm signal:

- a) Rate of collection of the gas. ( This helps in judging the severity of fault. The greater the rate of collection of the gas, the more severe the fault. )
- b) Colour of the gas. ( This helps in finding the affected material. )  
( See 6.1. )
- c) Combustibility of the gas. ( This helps in distinguishing the gases of disintegration of insulation from air. ) ( See 6.2. )

It is recommended that the chemical tests given in 6.3 be carried out to confirm the inferences drawn by the above indications.

**5.2** When oil-immersed apparatus is commissioned in service, it is likely that air dissolved in oil, trapped in core laminations and interstices in windings may be slowly given off resulting in the relay alarm operation. Also small quantity of air occluded in the windings may be shaken off when the first short-circuit is fed through the apparatus on an external fault.

**5.3** When oil and other organic insulation is burnt in a fault, combustible gases are produced. Oil burning due to short-circuit in iron

parts, corona or capacitance discharges will produce gases at a slow rate whereas a power short-circuit will produce gases at a high rate accompanied by an oil velocity surge.

It may be estimated that one kilowatt-second of arc energy generates approximately 75 cm<sup>3</sup> of gas, if the arc strikes in oil.

**5.4 Circulating pumps** used for cooling the apparatus sometimes suck outside air into the oil cooling circuit. This air may eventually get to the relay and operate it. The circulating pumps should be properly selected at the design stage so that they do not produce oil velocity surge of a magnitude that may operate the relay while starting the pumps.

**5.5 Wide variation in ambient temperature** in nitrogen filled transformers may result in gas accumulation in the relay and the operation of the alarm device.

## 6. ANALYSIS OF GAS

**6.1 Colour** — The gases collected in the relay lose their colours in a short time. Observations should, therefore, be made as quickly as possible. If colours are intermixed, it is difficult to draw any conclusion. The following colours are given as a guide:

<i>Colour of Gas</i>	<i>Identification</i>
Colourless	Air
White	Gas of decomposed paper and cloth insulation
Yellow	Gas of decomposed wood insulation
Grey	Gas of overheated oil due to burning of iron
Black	Gas of decomposed oil due to electric arc

**6.2 Combustibility** — A small quantity of gas may be drawn off through the test pet cock of the relay by a syringe and flame tested. About 2 to 5 cm<sup>3</sup> of gas is expelled into a 5 to 10 mm flame. If the flame brightens, the gas is combustible.

Incumbustible gas indicates air. Combustible gas indicates decomposed insulation and oil vapour.

**6.3 Chemical Test** — Several methods of chemical test to analyse the gases are being used and suitable commercial gas analysers are also being sold. The following methods are recommended.

**6.3.1 Method No. 1** — The principle of the working of a gas analyser apparatus is illustrated in Fig. 1. Just before the test, the apparatus is fed with two solutions of the following description. The proper solutions may be prepared in advance and preserved in stock in a dark place, in deep brown coloured glass containers but solutions preserved for 18 months or over should not be used. Best results are obtained with freshly made solutions:

**Solution No. 1** — 5 g silver nitrate ( $\text{Ag NO}_3$ ) dissolved in 100 ml of distilled water.

**Solution No. 2** — A weak solution of ammonia in water is slowly added to 100 ml of solution No. 1 until a white-curdled precipitate, which forms first, disappears in the mixture.

The gas analyser apparatus (see Fig. 1) is loaded with these solutions in the appropriate manner indicated. The apparatus is then connected to the test pet cock of the gas-operated relay by means of the adapter. The pet cock is slowly opened and the collected gas allowed to flow through the solutions in the apparatus. Tests should be made with small quantity of gas. The pet cock shall be closed before oil can enter the analyser. The reactions are interpreted as below:

<i>Observation</i>	<i>Identification</i>
Both solutions clear, no precipitate	The gas is air
<b>Solution 1</b> — White precipitate turning brown on exposure to sunlight	Gas of oil dissociation
<b>Solution 2</b> — Dark brown precipitate	Gas of decomposed paper, cotton or wood insulation

**6.3.2 Method No. 2** — The apparatus and the method of test is the same as described in Method 1. The solutions are as specified below:

**Solution No. 1** — Aqueous solution of ammonia

**Solution No. 2** — 100 mg palladous chloride ( $\text{PdCl}$ ) dissolved in 100 ml of distilled water.

The reactions are interpreted as below:

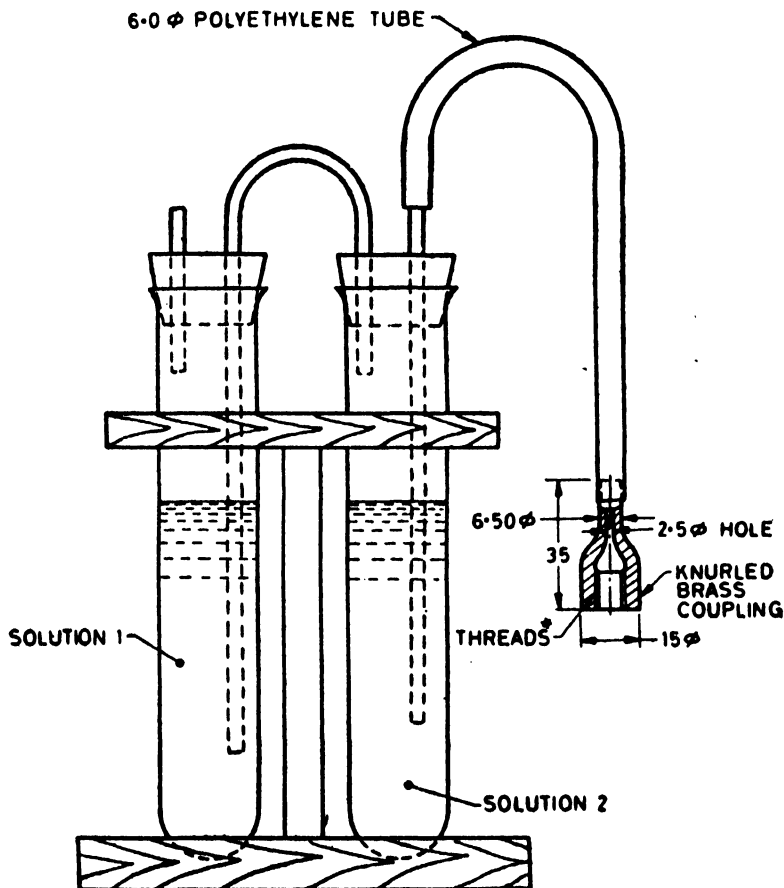
<i>Observation</i>	<i>Identification</i>
Both solutions clear, no precipitate	The gas is air
<b>Solution 1</b> — Brick red precipitate (even with a 2 to 3 cycle fault)	Gas of oil dissociation

**Observation**

**Solution 2** — Black precipitate in  
2 to 3 minutes  
Mere darkening

**Identification**

Gas of decomposed cotton,  
paper or wood insulation  
Small concentration but  
positive presence of gas  
of decomposed solid insulation



\*Threads to suit outlet (9.5 outside diameter) of test pet cock on gas-operated relay.

All dimensions in millimetres.

**FIG. 1 APPARATUS FOR GAS ANALYSIS**

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